

## High-Temperature Solar Cell Development

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The vast majority of satellites and near-earth probes developed to date have relied upon photovoltaic power generation. If future missions to probe environments close to the sun will be able to use photovoltaic power, solar cells that can function at high temperatures, under high light intensity, and high radiation conditions must be developed. For example, the equilibrium temperature of a Mercury surface station will be about 450 °C, and the temperature of solar arrays on the proposed "Solar Probe" mission will extend to temperatures as high as 2000 °C (although it is likely that the craft will operate on stored power rather than solar energy during the closest approach to the sun). Advanced thermal design principles, such as replacing some of the solar array area with reflectors, off-pointing, and designing the cells to reflect rather than absorb light out of the band of peak response, can reduce these operating temperature somewhat. Nevertheless, it is desirable to develop approaches to high-temperature solar cell design that can operate under temperature extremes far greater than today's cells.

Solar cells made from wide bandgap (WBG) compound semiconductors are an obvious choice for such an application. In order to aid in the experimental development of such solar cells, we have initiated a program studying the theoretical and experimental photovoltaic performance of wide bandgap materials. In particular, we have been investigating the use of GaP, SiC, and GaN materials for space solar cells. We will present theoretical results on the limitations on current cell technologies and the photovoltaic performance of these wide-bandgap solar cells in a variety of space conditions. We will also give an overview of some of NASA's cell developmental efforts in this area and discuss possible future mission applications.

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## Additional material for evaluation

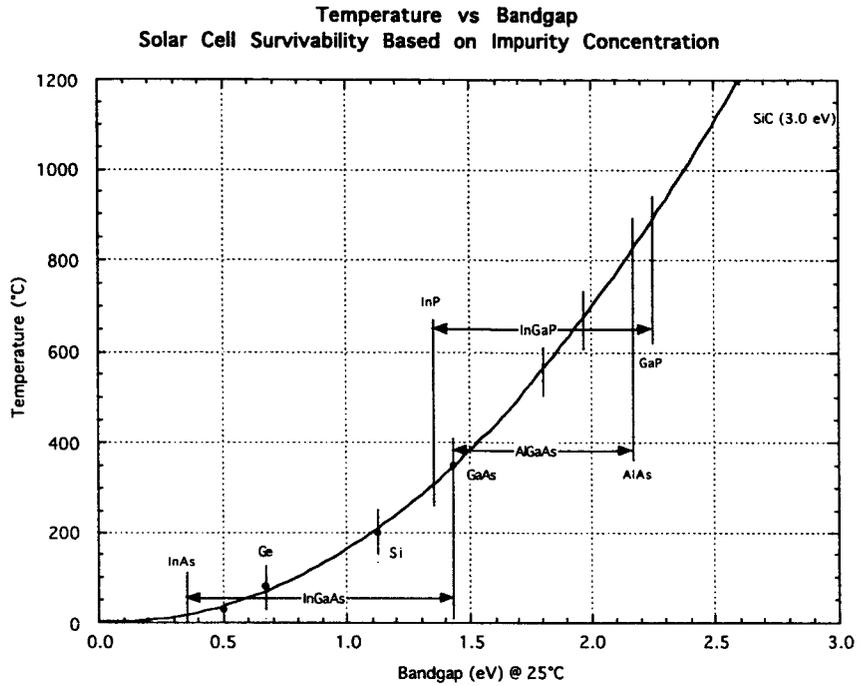


Figure 1: theoretical maximum survivable operating temperature as a function of bandgap.

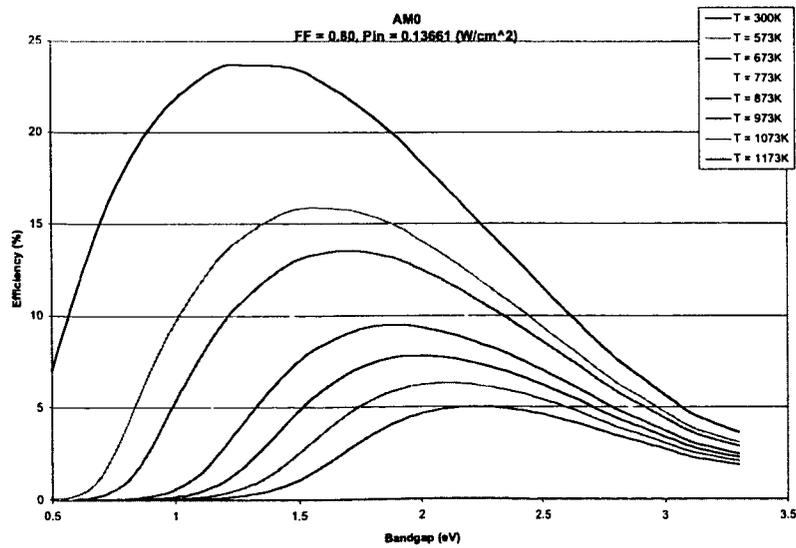


Figure 2: theoretical performance as a function of bandgap for high temperature operation.

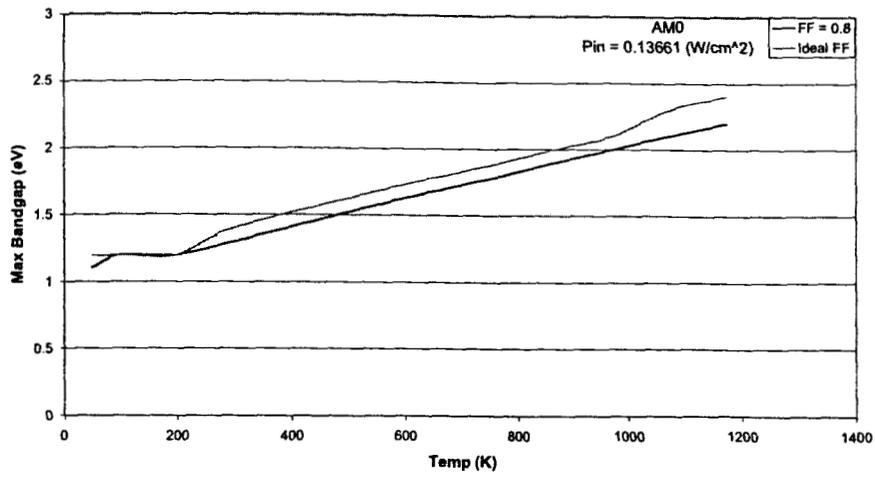


Figure 3: maximum-efficiency bandgap, as a function of operating temperature

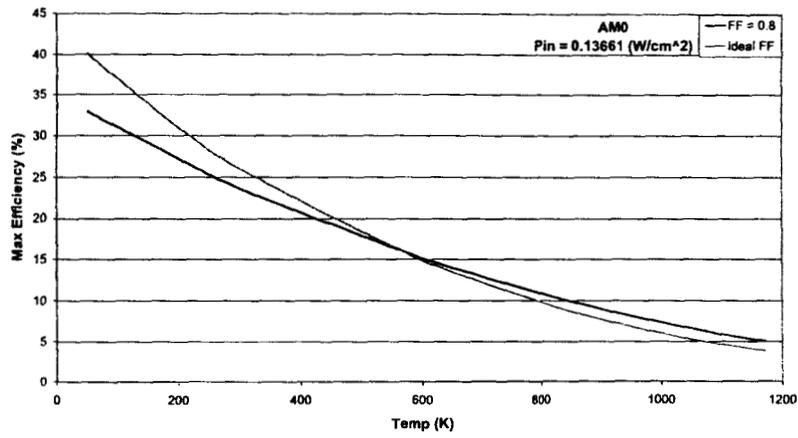


Figure 4. Efficiency of cell with optimum bandgap, as a function of operating temperature